Group 2: Design of the Life Support System for Mars Space Station

**Water Recovery System ISS**

**Notes about Multi- Filtration Beds**

Multi-Filtration consists of a particulate filter that is situated upstream of 6 Uni-beds in series.

Each Uni-bed is composed of an adsorption bed, made from activated carbon and an ion exchange bed.

The particulates are removed by filtration then the suspended organics are removed by the adsorption beds. Finally the inorganics salts are removed by ion-exchange resin beds.

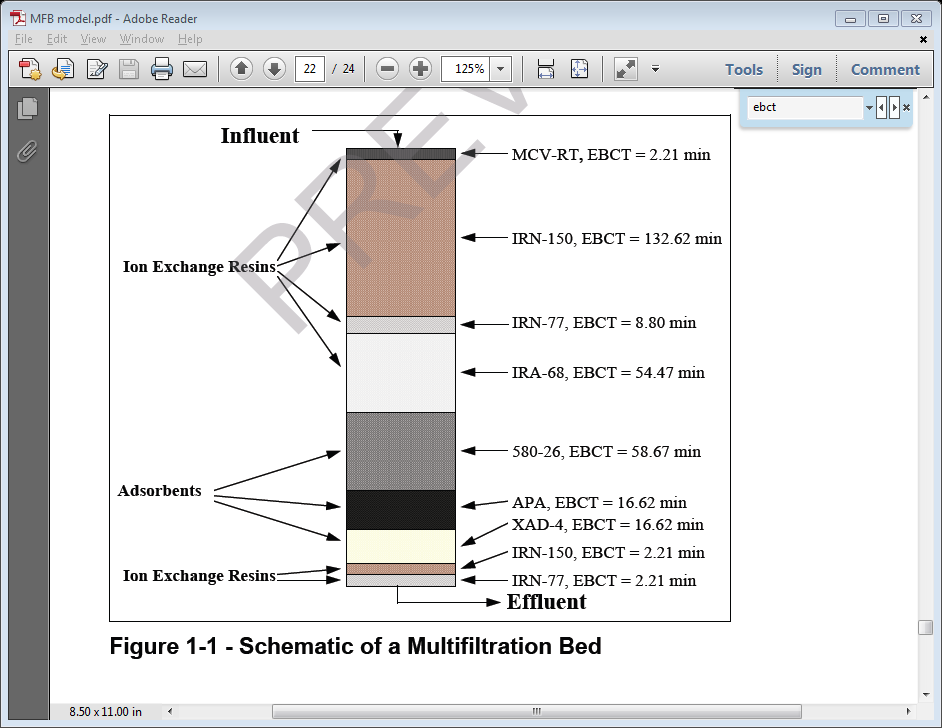
The multi-filtration canisters are designed for a 30 day life and thus need to be replaced on a monthly basis on board the LSS.

Figure : Schematic of Multi-filtration Bed

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| --- | --- | --- |
| **Media** | **Function** | **Media Description** |
| **MCV-77** | Disinfection | iodinated strong base anion, SBA, exchange resin |
| **IRN-150** | Removal of anions and cations | mixture of gel types strong acid cation, SAC, (IRN-77, H+ form) and SBA (IRN 78,OH- form) |
| **IRN-77** | Removal of cations | SAC gel exchange resin in the H+ form |
| **IRA-68** | Removal of strong and weak acids | weak base anion, WBA, gel exchange resin in the free base form |
| **580-26** | Removal of nonpolar organics | coconut-shell based activated carbon |
| **APA** | Removal of nonpolar organics | bituminous-coal based activated carbon |
| **XAD-4** | Removal of nonpolar organics | polymeric adsorbent |
| **IRN-150** | Removal of anions and cations | mixture of gel types SAC (IRN-77 , H+ form) and SBA (IRN-78, OH- form) |
| **IRN-77** | Removal of cations SAC | gel exchange resin in the H+ form |

Table : Filtration Bed Functions

**Notes about the Gas/ Liquid Separator**

* The PFD shows that the stream exiting the Reactor enters the Gas/Liquid Separator before moving on to the Ion-Exchange bed.
* The Stream Leaving the Reactor contains oxidized organics which need to be removed from the system.
* The Separator needs to be designed to remove the excess Oxygen before the Stream continues to the IX Bed.

Excess Oxygen can be damaging and so its removal is also important for protecting expensive equipment

**Methods of Removal**

* In order to determine the Method of Removal the phase and composition of the stream exiting the Reactor needs to be determined
* From the PFD it is known excess oxygen needs to be removed. If the oxygen is dissolved in a liquid stream, membrane degasification is an option as it is able to remove the dissolved gas by allowing it to pass through the Gas-Liquid Separation membrane whilst containing the liquid.
* The reactor by products will remain in the liquid and thus require the ion exchange bed to remove them.
* If the stream is completely in gaseous form it will require a gas separator and vice versa is the stream is completely in the liquid form.

**Further Information Required**

* The composition and Phases of the Reactor Exit Steam?
* Confirmation of what needs removed from the Reactor Exit Stream prior to it entering the Ion Exchange bed?
* If a Gas-Liquid Separation Membrane is the most appropriate method of Removing Oxygen?

**Once this information has been obtained a separator can be selected and designed which will fulfil the required stages between the reactor and the ion exchange bed.**

**Tanks**

**Daily Basis**

The water prior to Recycling must be stored. Based on daily recycling of 200.4 kg/day the tank would need to contain that volume plus a safety factor of 10%.

Thus the Water Tank before the process must store 220.5 kg, which corresponds to a volume of approximately 220.5 Litres. This volume includes the 20 kg/ day that will come from the urea treatment process that will join the water recovery process at the start.

Post Water Treatment

At 99 % Recovery Rate the amount of water obtained is 198.5 kg/day. Including a safety factor of 10% the total tank should accommodate 218.3 kg/day, corresponding to a volume of 218.3 litres.

|  |  |
| --- | --- |
| Tank Storage | Volume (Litres) |
| Water Pre-Treatment | 220.5 |
| Water Post-Treatment | 218.3 |

**Hourly Basis**

**Using the same method the following results are obtained?**

|  |  |
| --- | --- |
| Tank Storage | Volume (Litres) |
| Water Pre-Treatment | 9.2 |
| Water Post-Treatment | 9.1 |

**Twice a day Basis**

|  |  |
| --- | --- |
| Tank Storage | Volume (Litres) |
| Water Pre-Treatment | 110.3 |
| Water Post-Treatment | 109.2 |

**The Urine Tank for the Urine Processor should be collected and recycled once daily**

|  |  |
| --- | --- |
| Tank Storage | Volume (Litres) |
| Urine Pre-Treatment | 22 |

Materials?

Does this storage provide an acceptable hold up time?

Long term storage can occur in Teflon bags

List of Assumptions

* The Water Safety factor of 27454.3 kg is taken up but kept in storage rather than used and put through recycling process.
* It is assumed that all water used is completely conserved and there is no loss as all vapours end up contributing to the cabin humidity which is condensed before going through the recycling process.
* The required amount of water per day for the crew will be used up per day, thus the water is recycled on a daily basis.

The water will be 100% conserved based on the following techniques.

Any water that is passed through the body via perspiration and exhalation will contribute to the cabins humidity and be condensed by a cold plate before recycled through the water recovery process.

Any water from solids not recovered and thus removed form the space station will need replaced in re-supply mission.